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(54) **ELECTRO HYDROSTATIC ACTUATOR**

(75) Inventors: **Takaaki Onishi**, Hyogo (JP); **Taku Kondo**, Hyogo (JP); **Yasuto Onomichi**, Hyogo (JP); **Shogo Hagihara**, Hyogo (JP); **Ryo Takaki**, Hyogo (JP)

(73) Assignee: **Sumitomo Precision Products Co., Ltd.**, Amagasaki-shi (JP)

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F15B 15/18 (2006.01)
B64C 13/50 (2006.01)

(52) **U.S. Cl.**
CPC ***F15B 15/18*** (2013.01); *B64C 2013/506* (2013.01)

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CPC F15B 1/265; F15B 7/006; F15B 13/0444; F15B 15/1423; F15B 15/18; F15B 2211/20515
USPC 60/473, 475, 476, 478
See application file for complete search history.

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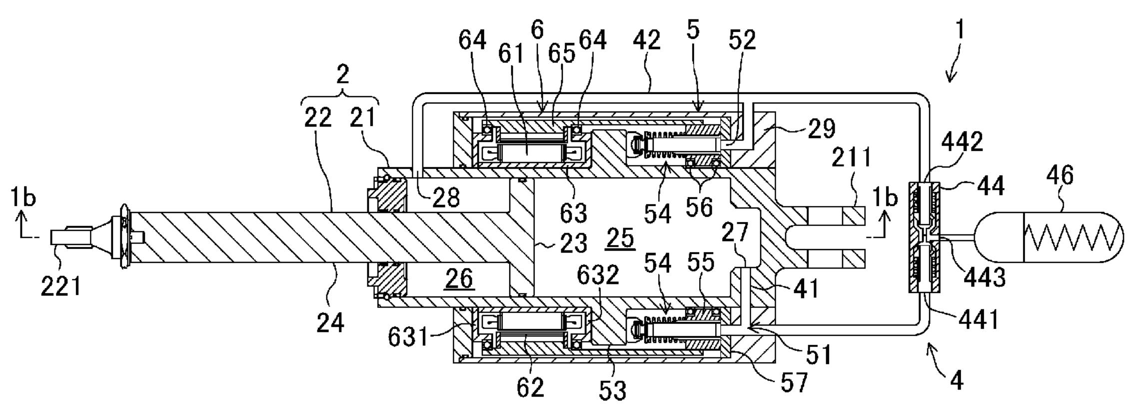
Primary Examiner — Dwayne J White
Assistant Examiner — Matthew Wiblin
(74) *Attorney, Agent, or Firm* — Alston & Bird LLP

(57) **ABSTRACT**

An electro hydrostatic actuator includes an actuator body, a hydraulic pump driven to supply operation oil to the actuator body, and an electric motor configured to drive the hydraulic pump. Each of the hydraulic pump and the electric motor is placed so as to surround the outer periphery of the actuator body, and the hydraulic pump and the electric motor are arranged in a direction along a center axis.

2 Claims, 3 Drawing Sheets



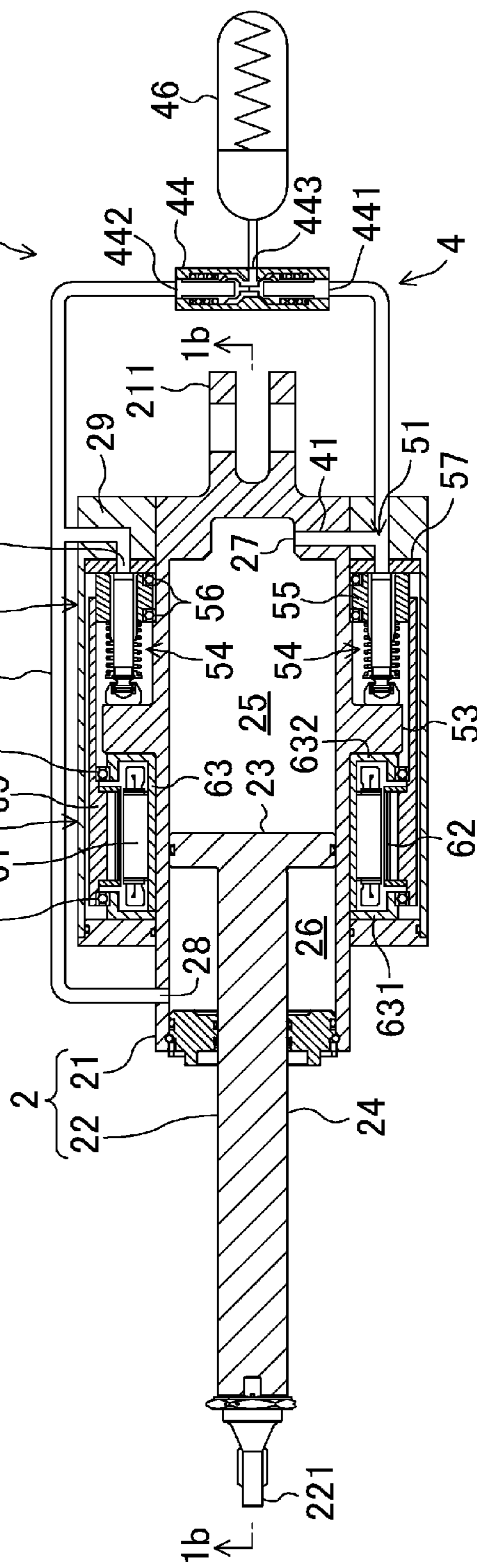

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FIG.1A

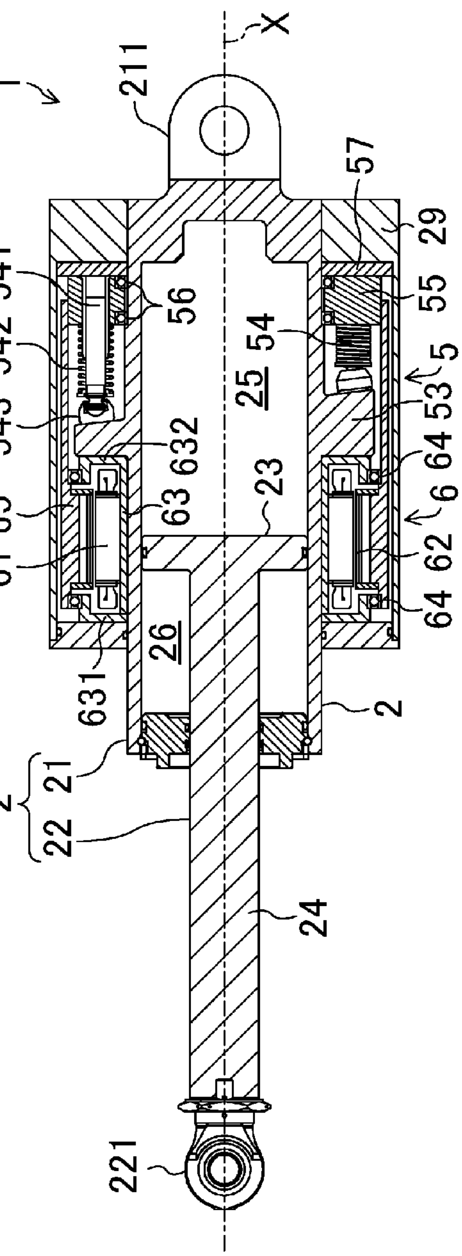
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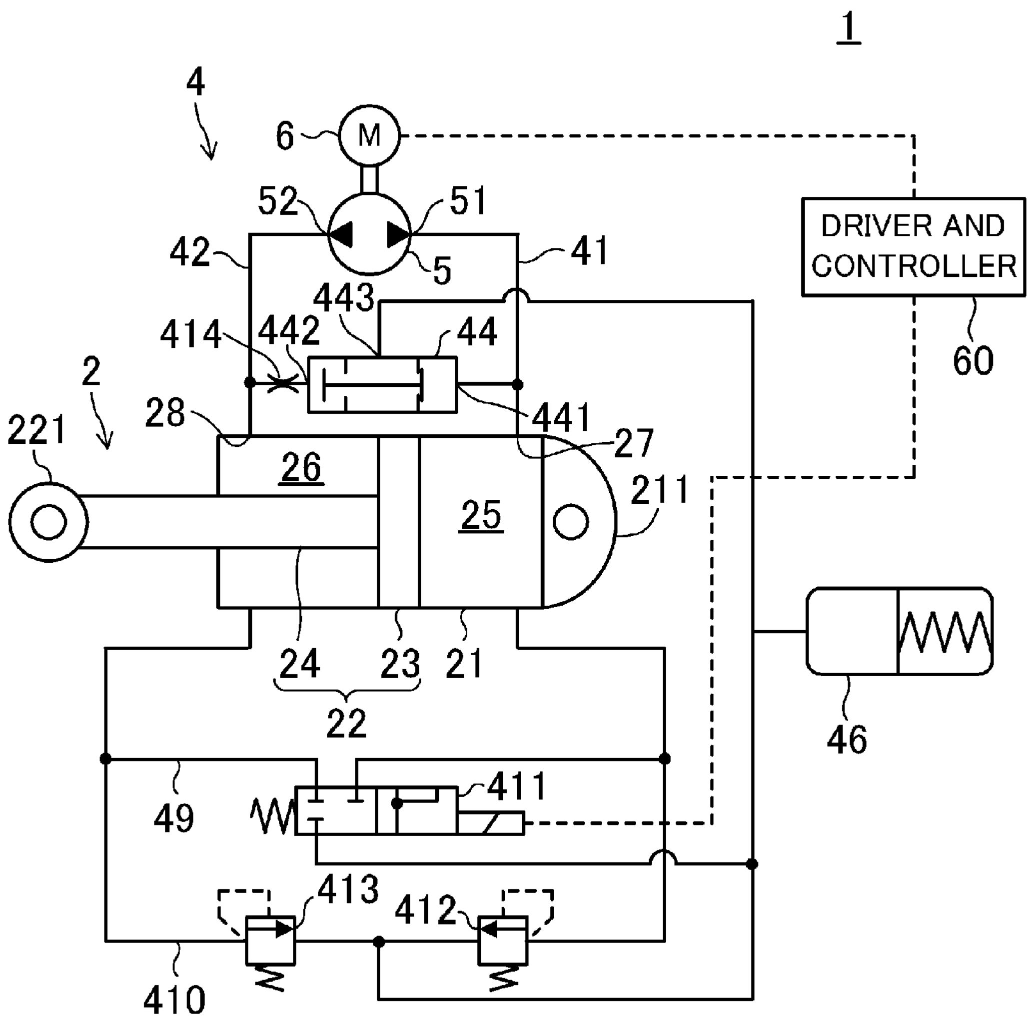
FIG.1B

FIG.2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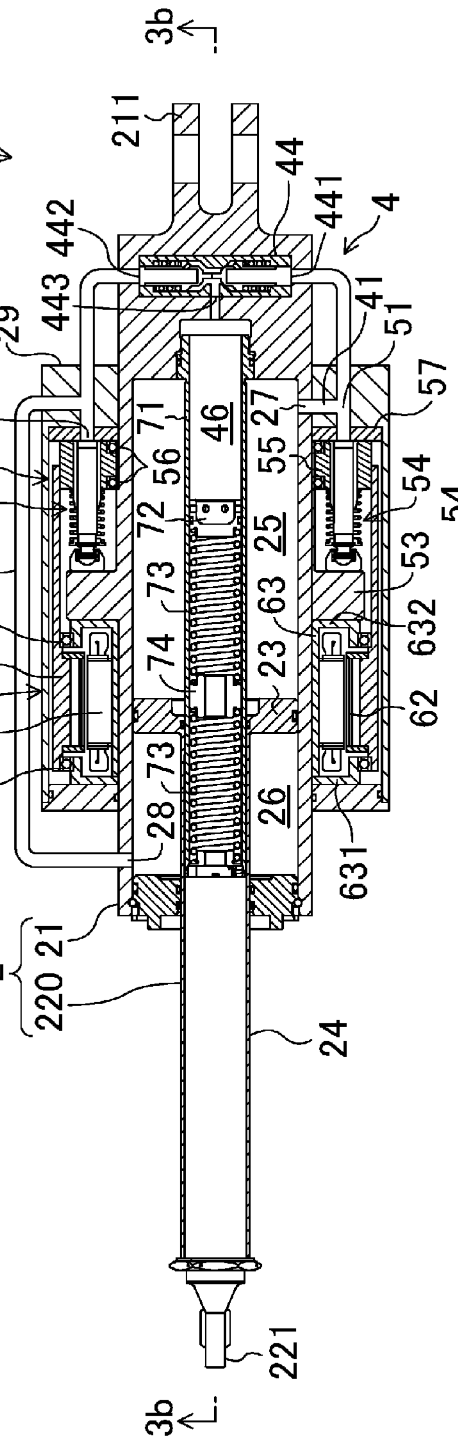

FIG.3A

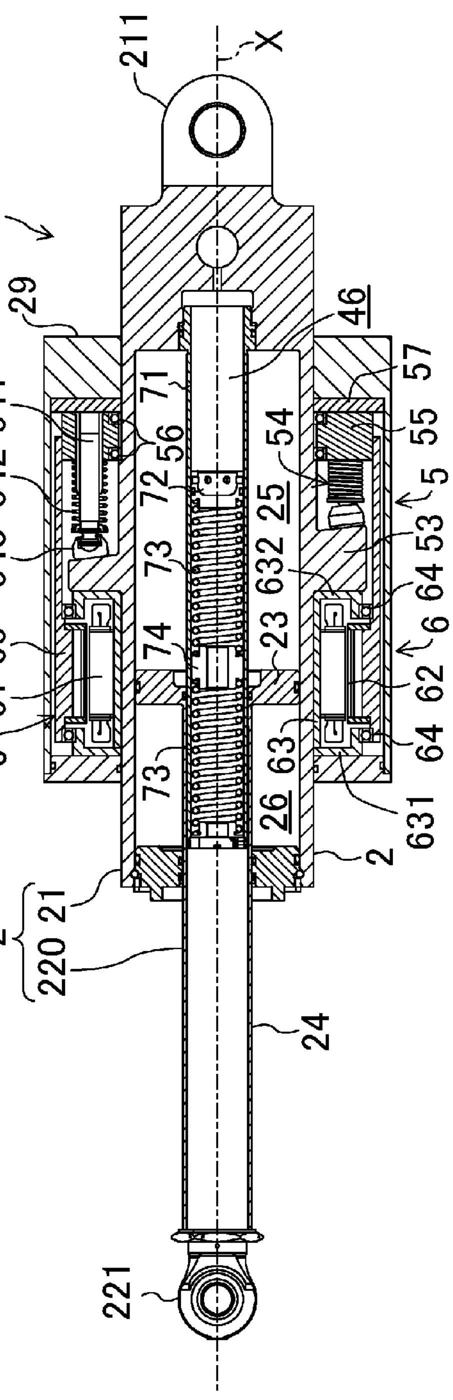

FIG.3B

ELECTRO HYDROSTATIC ACTUATOR

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to Japanese Patent Application No. 2011-201743 filed on Sep. 15, 2011, the disclosure of which including the specification, the drawings, and the claims is hereby incorporated by reference in its entirety.

BACKGROUND

A technique disclosed herein relates to an electro hydrostatic actuator (EHA) system which is applicable as various actuators for, e.g., an aircraft.

In recent years, from the point of improvement of fuel consumption of an aircraft and reduction of maintenance tasks of an aircraft, it has been proposed that an EHA is installed as an actuator for, e.g., a landing gear retraction/extension operation, a steering operation, a braking operation, and a fluid control operation, instead of a conventional hydraulic actuator system installed in an existing conventional aircraft (see, e.g., Japanese Patent Publication No. 2007-239974). An EHA system includes an extendable hydraulic linear actuator having a cylinder and a piston, a hydraulic pump, and an electric motor. The hydraulic pump is driven by the electric motor, thereby operating the extendable hydraulic linear actuator without a supply of oil pressure from an outside hydraulic source.

SUMMARY

In the EHA system described in the foregoing patent document, the hydraulic pump and the electric motor are placed at the side of the extendable hydraulic linear actuator. A specific configuration diagram is not provided in the foregoing patent document. However, the hydraulic pump and the electric motor are placed at the side of the extendable hydraulic linear actuator, e.g., an attachment flange is provided on an outer surface of the cylinder of the extendable hydraulic linear actuator, and the hydraulic pump and the electric motor are fixed to the extendable hydraulic linear actuator through the attachment flange.

However, in the EHA in which the hydraulic pump and the electric motor are placed at the side of the extendable hydraulic linear actuator in parallel and fixed through the attachment flange, the hydraulic pump and the electric motor are displaced from a center axis of the extendable hydraulic linear actuator. Thus, the position of the center of gravity of the EHA is greatly displaced from the center axis thereof.

In the EHA, a movable end of a piston rod and a fixed end of the cylinder, which are placed on the center axis of the hydraulic actuator, are each attached and fixed to aircraft equipment. The EHA in which the position of the center of gravity is greatly displaced from the center axis is extremely disadvantageous to satisfaction of vibration requirements derived from the aircraft. In order to satisfy the vibration requirements, it is necessary to increase the strength at the attachment portion of each of the hydraulic pump, the electric motor, and the extendable hydraulic linear actuator by increasing the size or thickness of the attachment flange. However, this results in an increase in weight of the EHA system.

The technique disclosed herein has been made in view of the foregoing, and it is an objective of the present disclosure to prevent a weight unbalance of an EHA without a weight increase.

An electro hydrostatic actuator disclosed herein includes an actuator body which includes a piston and a cylinder and which is extendable in a direction along a center axis; a hydraulic pump driven to supply operation oil to the actuator body; and an electric motor configured to drive the hydraulic pump. Each of the hydraulic pump and the electric motor is placed so as to surround an outer periphery of the actuator body, and the hydraulic pump and the electric motor are arranged in the direction along the center axis.

According to the foregoing configuration, each of the hydraulic pump and the electric motor is placed so as to surround the outer periphery of the actuator body which is extendable in the direction along the center axis. That is, since each of the hydraulic pump and the electric motor is placed so as to surround the center axis of the actuator body, the center of gravity of the electro hydrostatic actuator is located on the center axis or near the center axis. A weight unbalance is prevented or reduced, and, as a result, the vibration requirements for the electro hydrostatic actuator which is installed in an aircraft are likely to be satisfied easily.

Due to the improvement of the weight balance, a size increase of, e.g., an attachment flange required for the configuration as in the EHA system described in the foregoing patent document, i.e., the configuration in which the hydraulic pump and the electric motor are placed at the side of the actuator body is not necessary. This is advantageous to reduction in weight of the electro hydrostatic actuator. In addition, since the hydraulic pump and the electric motor are arranged in the direction along the center axis, the size of the electro hydrostatic actuator is reduced. This is also advantageous to the reduction in weight of the electro hydrostatic actuator.

The electric motor may include a stator fixed to the outer periphery of the actuator body, and a rotor arranged on an outer side relative to the stator and supported by the actuator body so as to rotate about the center axis of the hydraulic actuator. The hydraulic pump may be a swash plate type piston pump including a plurality of pistons arranged equiangularly so as to surround the outer periphery of the actuator body, a cylinder block which holds each of the pistons such that the each of the pistons reciprocates in the direction along the center axis and which is supported by the actuator body so as to rotate about the center axis, and a swash plate integrally provided with the actuator body. The rotor of the electric motor and the cylinder block of the hydraulic pump may be connected together through a torque transmission member arranged at a position on an outer side in a radial direction relative to the electric motor and the hydraulic pump.

The rotor configured "to rotate about the center axis" means not only the rotor which is rotatable about the center axis, but also the rotor which is substantially rotatable about the center axis in the state in which the rotation center of the rotor is positioned near the center axis. Similarly, the cylinder block configured "to rotate about the center axis" means not only the cylinder block which is rotatable about the center axis, but also the cylinder block which is substantially rotatable about the center axis in the state in which the rotation center of the cylinder block is positioned near the center axis.

According to the foregoing configuration, the rotor of the electric motor is supported by the actuator body, and rotates about the center axis. Thus, a rotation balance is obtained in driving of the electric motor. In addition, the cylinder block of the hydraulic pump which is connected to the rotor of the electric motor through the torque transmission member to be rotatably driven is supported by the actuator body so as to rotate about the center axis of the actuator body, resulting in no eccentric rotation. This is advantageous to prevention of abnormal vibration at the electro hydrostatic actuator.

Since the stator of the electric motor fixed to the outer periphery of the actuator body has a diameter larger than that of the actuator body, a relatively-large diameter of the stator is ensured. This is advantageous to ensuring of an output torque of the electric motor. On the other hand, since the thickness of the rotor (i.e., the thickness of the rotor in the radial direction) arranged around the outer periphery of the stator is not necessarily large, the outermost diameter of the electric motor can be reduced as much as possible. Thus, the high torque can be ensured, and the reduction in size of the electro hydrostatic actuator can be realized.

The swash plate may be arranged between each of the pistons and the electric motor which are arranged in the direction along the center axis, and an outlet port and an inlet port of the hydraulic pump may be formed on an end side of the actuator body opposite to the swash plate in the direction along the center axis.

Thus, even in the configuration in which the actuator body and the hydraulic pump are arranged substantially coaxially with each other, there is an advantage that pipes connected to the outlet and inlet ports and forming a hydrostatic circuit are easily arranged.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A and **1**B are cross-sectional views of an electro hydrostatic actuator system.

FIG. **2** is a hydrostatic circuit diagram of the electro hydrostatic actuator system illustrated in FIGS. **1**A and **1**B.

FIGS. **3**A and **3**B are cross-sectional views of the electro hydrostatic actuator system.

DETAILED DESCRIPTION

An embodiment of an electro hydrostatic actuator system (hereinafter referred to as an "EHA system") will be described below with reference to drawings. The embodiment will be set forth merely for purpose of an example in nature. FIG. **1**A is a cross-sectional view of an EHA system **1**, and FIG. **1**B is a cross-sectional view along a **1***b*-**1***b* line illustrated in FIG. **1**A. FIG. **2** illustrates an entire configuration of a hydrostatic circuit of the EHA system **1**. The EHA system **1** includes a hydraulic actuator **2** and a hydrostatic circuit **4**. The EHA system **1** is installed in an aircraft as, e.g., an actuator system for retraction/extension of a landing gear, a flight control operation, a braking operation, and a steering operation.

The hydraulic actuator **2** is an extendable linear actuator which includes a cylinder **21** and a piston **22** and which is, as described later, extendable in a direction along a center axis X by a supply of operation oil. The piston **22** includes a piston head **23** accommodated and reciprocating in the cylinder **21**, and a piston rod **24** integrally connected to the piston head **23** and arranged so as to protrude from the cylinder **21**. Although not shown in the figure, a tip end of the piston rod **24** is, as a movable end **221**, attached and fixed to an attachment part of aircraft equipment. In addition, in the hydraulic actuator **2**, a cylinder end of the cylinder **21** which is an end opposite to the movable end **221** of the piston rod **24** in the direction along the center axis X is, as a fixed end **211**, attached and fixed to an attachment part of the aircraft equipment. Thus, the hydraulic actuator **2** is attached and fixed to the aircraft equipment at two ends (i.e., the movable end **221** and the fixed end **211**) positioned on the center axis X.

An inside of the cylinder **21** of the hydraulic actuator **2** is divided into a first chamber **25** on a side closer to a head relative to the piston head **23** and a second chamber **26** on a side closer to a rod relative to the piston head **23**. A port (i.e., a first port **27** and a second port **28**) through which operation oil flows in/out is formed in each of the first chamber **25** and the second chamber **26**.

Referring to FIG. **2**, the hydrostatic circuit **4** is a closed circuit provided between the hydraulic actuator **2** and a hydraulic pump **5**. The hydrostatic circuit **4** includes a first oil path **41** connecting the first port **27** of the hydraulic actuator **2** and a first port **51** of the hydraulic pump **5** together, and a second oil path **42** connecting the second port **28** of the hydraulic actuator **2** and a second port **52** of the hydraulic pump **5** together.

The hydrostatic circuit **4** further includes an inverse shuttle valve **44** arranged between the first oil path **41** and the second oil path **42** so as to be parallel to the hydraulic pump **5**. The inverse shuttle valve **44** includes two inlet ports **441**, **442**, i.e., a port communicating with the first oil path **41** and a port communicating with the second oil path **42**, and a single outlet port **443** communicating with a reservoir **46** configured to absorb a fluctuation in total capacity of the first chamber **25** and the second chamber **26** of the hydraulic actuator **2**. The inverse shuttle valve **44** has a function to select a connection between one of the two inlet ports **441**, **442** having a lower pressure and the outlet port **443**. Note that a flow restrictor orifice **414** (illustrated only in FIG. **2**) is arranged between the inverse shuttle valve **44** and the second chamber **26** to adjust a flow rate from the second chamber **26** to the reservoir **46** through the inverse shuttle valve **44**.

The hydraulic pump **5** is a pump which includes the first and second ports **51**, **52** and which is capable of switching an inlet and an outlet of operation oil between the first port **51** and the second port **52**. Referring to FIG. **1**, the hydraulic pump **5** is a swash plate type piston pump. Note that the type of the hydraulic pump **5** is not limited to the foregoing. A specific configuration of the hydraulic pump **5** will be described later.

An electric motor **6** is connected to the hydraulic pump **5**, and is driven to drive the hydraulic pump **5** (see FIG. **1**). A specific configuration of the electric motor **6** will be described later. The followings are electrically connected to the electric motor **6** (see a dashed line in FIG. **2**): a controller configured to control at least the electric motor **6**; and a driver **60** (hereinafter simply referred to as a "driver **60**") configured to supply power to the electric motor **6** depending on a control signal(s) from the controller. The driver **60** supplies power to the electric motor **6** to drive the electric motor **6**. The switching of the output flow direction of the hydraulic pump **5** and the input flow direction of the hydraulic pump **5** is performed by reversing a rotation direction of the electric motor **6**.

A fail-safe hydraulic circuit which is not shown in FIG. **1** is also provided in the hydrostatic circuit **4**. The fail-safe hydraulic circuit includes a fourth oil path **49** and a fifth oil path **410** each provided to cause the first chamber **25** and the second chamber **26** of the hydraulic actuator **2** to communicate with each other. A solenoid valve **411** controlled by the driver **60** is arranged on the fourth oil path **49**, and a first relief valve **412** and a second relief valve **413** each opened at equal to or higher than a predetermined pressure are arranged on the fifth oil path **410**. The fifth oil path **410** is, at part thereof between the first relief valve **412** and the second relief valve **413**, connected to the reservoir **46**.

The solenoid valve **411** is a three-port two-way switching valve including a port communicating with the first oil path **41**, i.e., with the first chamber **25** of the hydraulic actuator **2**, a port communicating with the second oil path **42**, i.e., with the second chamber **26** of the hydraulic actuator **2**, and a port communicating with the reservoir **46**. The solenoid valve **411** is switchable between a first state (state illustrated in FIG. **2**) in which the first chamber **25** and the second chamber **26** of the hydraulic actuator **2** and the reservoir **46** are disconnected from each other and a second state in which the first chamber **25**, the second chamber **26**, and the reservoir **46** communicate with each other. In such a manner that the solenoid valve **411** is normally in the first state and is, on the other hand, in the second state upon emergency (upon fail), the hydraulic actuator **2** can be extended even if the hydraulic pump **5** is not operated.

A basic operation of the EHA system **1** configured as described above is as follows. That is, in order to extend the hydraulic actuator **2**, the electric motor **6** is driven by the driver **60** with the solenoid valve **411** of the hydrostatic circuit **4** being switched to the first state referring to FIG. **2**, and then the hydraulic pump **5** is driven such that operation oil is discharged from through the first port **51**. This allows the operation oil to be supplied to the first chamber **25** through the first oil path **41** and the first port **27**, and the piston **22** moves to the left as viewed in FIG. **1**. As a result, the hydraulic actuator **2** is extended.

In association with the supply of operation oil through the first oil path **41** to the inverse shuttle valve **44**, the inverse shuttle valve **44** causes the second oil path **42** and the reservoir **46** to communicate with each other (see the state illustrated in FIG. **2**). Thus, operation oil discharged from the second chamber **26** by the movement of the piston **22** returns to the second port **52** of the hydraulic pump **5** through the second oil path **42**. Meanwhile, in order to compensate for a volume capacity difference between the first chamber **25** and the second chamber **26** of the hydraulic actuator **2**, operation oil is supplied from the reservoir **46** to the second port **52** of the hydraulic pump **5** through the inverse shuttle valve **44** and the restrictor orifice **414**.

Conversely, in order to retract the hydraulic actuator **2**, the electric motor **6** is driven with the solenoid valve **411** being switched to the first state, and then the hydraulic pump **5** is driven such that operation oil is discharged through the second port **52**. This allows the operation oil to be supplied to the second chamber **26** through the second oil path **42** and the second port **28**, and the piston **22** moves to the right as viewed in FIG. **1**. As a result, the hydraulic actuator **2** is retracted.

Although not shown in the figure, the inverse shuttle valve **44** causes the first oil path **41** and the reservoir **46** to communicate with each other in association with the supply of operation oil through the second oil path **42** to the inverse shuttle valve **44**. Thus, part of operation oil discharged from the first chamber **25** by the movement of the piston **22** returns to the first port **51** of the hydraulic pump **5** through the first oil path **41**, and part of the operation oil reaches the reservoir **46** through the inverse shuttle valve **44**.

Referring to FIG. **1**, in the EHA system **1**, the electric motor **6** and the hydraulic pump **5** are placed so as to surround the outer periphery of the hydraulic actuator **2**, and are arranged in the direction along the center axis X of the hydraulic actuator **2** (in the right-left direction as viewed in FIG. **1**). Note that, for the sake of clarity of description, the left side as viewed in FIG. **1** is hereinafter referred to as a "front side," and the right side as viewed in FIG. **1** is hereinafter referred to as a "rear side."

In a substantially middle position of an outer peripheral surface of the cylinder **21** in the direction along the center axis X, a swash plate **53** of the hydraulic pump **5** is integrally connected with the cylinder **21**. The swash plate **53** of the hydraulic pump **5** is also vertically arranged on the outer peripheral surface of the cylinder **21** so as to outwardly extend in a radial direction. The electric motor **6** including a stator **61** and a rotor **62** is arranged on the front side relative to the swash plate **53**.

A bearing support **63** configured to rotatably support the rotor **62** is fitted onto the cylinder **21** along the outer peripheral surface thereof, and the stator **61** of the electric motor **6** is fixed to the outer peripheral surface of the cylinder **21** through the bearing support **63**.

The bearing support **63** includes standing walls **631**, **632** respectively on the front side (left side as viewed in FIG. **1**) and the rear side (right side as viewed in FIG. **1**) relative to the stator **61**. In addition, the standing walls **631**, **632** outwardly extend in the radial direction such that a pair of bearings **64** are supported at positions on an outer side in the radial direction relative to the stator **61**. One of the bearings **64** is attached and fixed to an outer end of the front standing wall **631** in the radial direction, and the other bearing **64** is attached and fixed to an outer end of the rear standing wall **632** in the radial direction.

The rotor **62** of the electric motor **6** is, between the bearings **64** arranged apart from each other in the direction along the center axis X, arranged with a predetermined distance from the stator **61** in the radial direction. As described above, in the electric motor **6**, the stator **61** is arranged on an inner side in the radial direction, and the rotor **62** is arranged in the outer side in the radial direction.

A cylindrical torque transmission member **65** extending toward the rear side in the direction along the center axis X beyond the swash plate **53** is arranged on an outer peripheral side of the rotor **62**, and the rotor **62** and the torque transmission member **65** are fixed together so as to rotate in an integrated manner. The bearings **64** and the torque transmission member **65** are connected together along an inner peripheral surface thereof. Thus, the rotor **62** and the torque transmission member **65** are supported by the hydraulic actuator **2** so as to rotate about the center axis X of the hydraulic actuator **2**. The torque transmission member **65** is a member configured to transmit a torque of the electric motor **6** to the hydraulic pump **5** to drive the hydraulic pump **5**. As described above, the configuration in which the rotor **62** is arranged on the outer side in the radial direction is employed as the configuration of the electric motor **6**, and therefore the torque transmission member **65** extending in the direction along the center axis X can be arranged on the outermost position in the radial direction. Thus, there is an advantage that the torque transmission member **65** can be easily arranged.

The hydraulic pump **5** is, as described above, the swash plate type piston pump, and includes a plurality of pistons **54** arranged equiangularly around the outer peripheral surface of the cylinder **21**. Each of the pistons **54** includes a piston body **541** reciprocating in the direction along the center axis X, a spring **542** arranged coaxially with the piston body **541**, and a piston shoe **543** attached to a front end (end on the left side as viewed in FIG. **1**) of the piston body **541** and sliding on the swash plate **53**.

The pistons **54** are held by an annular cylinder block **55**. The cylinder block **55** is attached to the outer peripheral surface of the cylinder **21** through bearings **56**, thereby rotating about the center axis X. In addition, the torque transmission member **65** is fixed to the cylinder block **55**. Thus, when the electric motor **6** is driven, a motor torque is transmitted to the cylinder block **55** through the torque transmission member **65**, and the cylinder block **55** rotates about the center axis X.

A valve plate **57** including the first port **51** and the second port **52** is arranged at the rear of the cylinder block **55**. As described above, in association with the rotation of the cylinder block **55** about the center axis X, each of the pistons **54** revolves around the center axis X on an outer peripheral side of the cylinder **21**, and reciprocates in the direction along the center axis X. In association with the revolution and reciprocation of the pistons **54**, operation oil is discharged through the first port **51** or the second port **52**.

The electric motor **6** and the hydraulic pump **5** are accommodated in a housing **29** attached and fixed to the cylinder **21**. In the illustrated example, part of the first oil path **41** and part of the second oil path **42** are formed in the housing **29**.

As in the foregoing, in the EHA system **1**, the electric motor **6** and the hydraulic pump **5** are placed so as to surround the outer periphery of the body of the hydraulic actuator **2**, and are arranged in the direction along the center axis X. This allows the center of gravity of the EHA system **1** to be positioned on the center axis X or be positioned near the center axis X. As a result, a weight unbalance of the EHA system **1** is prevented or reduced. Thus, vibration requirements for the EHA system **1** as various actuators for the aircraft can be easily satisfied.

Since the electric motor **6**, the hydraulic pump **5**, and the hydraulic actuator **2** are integrally connected without the weight unbalance, the weight of the EHA system **1** can be reduced. This is advantageous for the EHA system **1** to be installed in the aircraft.

The rotor **62** of the electric motor **6** is rotatably arranged about the center axis X of the hydraulic actuator **2**, and therefore such a configuration provides a rotation balance in driving of the electric motor **6**. This is advantageous to prevention of abnormal vibration of the EHA system **1**. Similarly, the cylinder block **55** of the hydraulic pump **5** is also rotatably arranged about the center axis X, and therefore such a configuration provides a rotation balance in driving of the hydraulic pump **5**. This is advantageous to the prevention of the abnormal vibration of the EHA system **1**.

The electric motor **6** is placed around the outer periphery of the hydraulic actuator **2**. Thus, the diameter of the stator **61** is larger than the outer diameter of the cylinder **21**, and therefore a relatively-large diameter of the stator **61** is ensured. This is advantageous to ensuring of a high torque of the electric motor **6**. In addition, the thickness of the rotor **62** (i.e., the thickness of the rotor **62** in the radial direction) is not so large, and the outermost diameter of the electric motor **6** is relatively small. This is advantageous to reduction in size of the EHA system **1**.

The configuration in which the rotor **62** is arranged on the outer side in the radial direction of the electric motor **6** allows the arrangement of the torque transmission member **65** at the outermost position in the radial direction. Thus, the torque transmission member **65** can be easily arranged, and this is, as a result, advantageous to reduction in size and weight of the EHA system **1**.

The first and second ports **51**, **52** of the hydraulic pump **5** are placed on a rear end side of the hydraulic actuator **2**. Thus, in the EHA system **1** in which the hydraulic actuator **2** and the hydraulic pump **5** are arranged coaxially with each other, pipes of the EHA system **1** can be easily arranged. This is also advantageous to the reduction in size and weight of the EHA system **1**.

FIG. **3**A is a cross-sectional view of an EHA system **10** in which a reservoir **46** is provided inside a hydraulic actuator **2**. FIG. **3**B is a cross-sectional view along a **3***b*-**3***b* line illustrated in FIG. **3**A. Note that the same reference numerals as those shown in the EHA system **1** illustrated in FIG. **1** are used to represent equivalent elements in the EHA system **10** illustrated in FIGS. **3**A and **3**B.

In the reservoir embedded type EHA system **10**, a piston rod **220** is configured to have a hollow. A standpipe **71** arranged coaxially with a center axis X in a cylinder **21** and fixed to the cylinder **21** is inserted into a hollow of the piston rod **220**. An inside of the standpipe **71** serves as the reservoir **46** which stores operation oil, and a port communicating with the reservoir **46** is formed in a rear end part of the standpipe **71**. Note that, in the reservoir embedded type EHA system **10** exemplified in FIGS. **3**A and **3**B, an inverse shuttle valve **44** is also embedded in a rear end part of the cylinder **21**.

The followings are embedded in the standpipe **71**: a free piston **72** defining the reservoir **46**; and a coil spring **73** configured to elastically support the free piston **72** such that the free piston **72** reciprocates in a direction along the center axis X. The coil spring **73** biases the free piston **72** in a direction in which a reservoir capacity is decreased. In the illustrated example, two coil springs **73** are arranged in series with an intermediate member **74** being interposed between the coil springs **73**. Instead of such a configuration, a signal coil spring may be used.

Since the reservoir **46** is embedded in the reservoir embedded type EHA system **10**, the size of the EHA system **1** can be further reduced, and possibility of installing the EHA system **10** in aircraft equipment can be enhanced.

The hydrostatic circuit **4** illustrated in FIG. **2** has been set forth merely for purpose of an example in nature. Any circuit configurations may be employed for circuits forming the EHA systems **1**, **10**.

The hydraulic pump **5** is not limited to the swash plate type piston pump. As long as the hydraulic pump **5** is, e.g., a rotary hydraulic pump which is arranged so as to surround the outer periphery of the hydraulic actuator **2** and which is rotatable about the center axis X, such a rotary hydraulic pump is applicable to the technique disclosed herein.

What is claimed is:

1. An electro hydrostatic actuator, comprising:

an actuator body which includes a piston and a cylinder and which is extendable in a direction along a center axis;

a hydraulic pump driven to supply operation oil to the actuator body; and

an electric motor configured to drive the hydraulic pump, wherein:

each of the hydraulic pump and the electric motor is placed so as to surround an outer periphery of the actuator body;

the hydraulic pump and the electric motor are arranged in the direction along the center axis;

the electric motor comprises:

a stator fixed to the outer periphery of the actuator body; and

a rotor arranged on an outer side relative to the stator and supported by the actuator body so as to rotate about the center axis;

the hydraulic pump is a swash plate type piston pump comprising:

a plurality of pistons arranged equiangularly so as to surround the outer periphery of the actuator body;

a cylinder block which holds each of the pistons such that the each of the pistons reciprocates in the direction along the center axis and which is supported by the actuator body so as to rotate about the center axis; and

a swash plate integrally connected to the actuator body; and

the rotor of the electric motor and the cylinder block of the hydraulic pump are connected together through a torque transmission member arranged at a position on an outer side in a radial direction relative to the electric motor and the hydraulic pump.

2. The electro hydrostatic actuator of claim **1**, wherein

the swash plate is arranged between each of the pistons and the electric motor which are arranged in the direction along the center axis, and

an outlet port and an inlet port of the hydraulic pump are placed on an end side of the actuator body opposite to the swash plate in the direction along the center axis.

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